TABLE 3.—*Mean temperature of bad fire seasons, district No. 1, from eight Idaho and eight Montana cooperative stations*

Year	June		July		August	
	Normal	Actual	Normal	Actual	Normal	Actual
		°		°		°
1910		60.2		68.2		61.6
	°		°		°	
1919	59.2	59.4	65.8	67.1	64.4	65.1
1926		61.3		69.2		64.1
1929		57.5		65.7		67.6

SUMMARY

Fire season normal (June, July, August)	63.1
Bad season average	63.9
The 1929, 3-month average	63.6
1929 departure from normal	+.5
1929 departure from bad season average	−.3

TABLE 4.—*Average precipitation (inches) of bad fire seasons, district No. 1, from eight Idaho and eight Montana cooperative stations, average elevation, 2,641 feet*

Year	Precipitation for the preceding 9 months		June		July		August	
	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual
1910		17.42		0.74		0.24		0.42
1919	17.84	17.81	1.84	.33	0.98	.22	0.94	.96
1926		13.23		1.74		.49		2.29
1929		11.52		2.21		.31		.18

SUMMARY

Fire season normal (June, July, August)	3.76
Bad fire-season average	2.54
Total of 1929 monthly averages (June, July, August)	2.70
1929 departure from fire-season normal	−1.06
1929 departure from bad season average	+.16

TABLE 5.—*A comparison, June, July, and August, 1929, precipitation averages (inches) as obtained at 16 cooperative stations, average elevation 2,641 feet and those obtained at 18 fire-weather stations, average elevation, 4,188 feet*

Month	16 cooperative stations			18 fire-weather stations		
	Normal	Actual	Departure	Normal	Actual	Departure
June	1.84	2.21	+0.37	2.10	2.69	+0.59
July	.98	.31	−.67	.54	.18	−.36
August	.94	.18	−.76	.70	.27	−.43
The season	3.76	2.70	−1.06	3.34	3.14	−.20

TABLE 6.—*Precipitation averages by decades Weather Bureau stations outside district No. 1*

Decades	Spokane	St. Paul	St. Louis	New York	New Orleans	Los Angeles	San Francisco	Portland
1841–1850		14.49	45.34		53.64			
1851–1860		12.06	45.73		51.46		22.22	
1861–1870		14.80	40.76				24.89	
1871–1880		16.63	37.13	42.81	65.47		24.32	53.19
1881–1890	18.46	12.49	39.85	48.06	60.18	18.74	24.60	45.75
1891–1900	18.28	13.78	36.12	42.45	48.40	12.03	19.51	39.16
1901–1910	16.14	15.58	36.52	43.48	55.89	15.39	20.72	41.02
1911–1920	14.03	14.96	37.93	40.01	63.02	15.20	20.82	39.57
1921–1930	13.79	12.72	38.33	41.32	63.16	12.82	20.72	37.38

(Stations outside the State of Washington have a basis of less than 9 years in the last decade. The Spokane value, on the basis of normal precipitation in 1930). At this writing, October 17, 1930, it would seem as if 1930 will be a year of less than normal precipitation.

DISASTROUS FIRE WEATHER OF SEPTEMBER, 1929

By CHARLES I. DAGUE, FIRE WEATHER SERVICE

[Weather Bureau Office, Portland, Oreg.]

The outstanding features of the fire-weather season for 1929 were its extreme dryness, its length, and the heavy fire losses in September, and subsequently thereto, west of the Cascades in Oregon and Washington. It was by far the most severe and most strenuous season within the history of organized forest-fire protection in these two States, and probably for as far back as we have any record or knowledge of forest fires for these sections. There have been seasons with heavier fire losses, but they were before the time of organized protection. The extreme southwestern portion of Oregon and of northwestern California sustained their heaviest forest fire losses for the season during the last decade in November and the first week in December.

The worst drought in the history of Weather Bureau records prevailed from June 20 to December 7, not only in Oregon and Washington, but in all the far Western States as well. November was the fifth successive month with deficient precipitation, the average for the five months in Oregon, June to November, being 1.81 inches which is only 20 per cent of the normal; precipitation at the regular Weather Bureau stations in the far Western States averaged only 27 per cent of the normal for this 5-month period. It is also interesting to note in this connection that the average precipitation for November in Oregon was only 8 per cent of the normal, the normal for 94 stations being 4.52 inches. Of the 19 months ending with November, 1929, 17 months were drier than normal, with the total precipitation for this 19-month period in Oregon being only 62 per cent of the normal. Thus both the years of 1928 and 1929 were very dry, being climaxed by one of the worst droughts of record in the far West as well as by far the most critical fire weather conditions known.

Maj. Edward H. Bowie, district forecaster at San Francisco, Calif., in his paper on the Long Dry Season of 1929 in the Far West, published in the MONTHLY WEATHER REVIEW for November, 1929, very aptly explained the anomalies that caused the dry weather for the normally dry months of July and August to continue on through September, October, November, and the first week in December. These anomalies were due to the continuation through September and October of high or relatively high barometric pressure over the North Pacific Ocean in latitudes where ordinarily found only in the summer seasons, and of extraordinarily high barometric pressure in November in general along and off the West Coast, over the Plateau Region and western Canada. The cyclones of the North Pacific Ocean were unable to penetrate these high barometric pressures and their systems of winds, and were forced to move instead, along the northern periphery of the high pressure area in high latitudes. It was not until the barometric pressure rose in high latitudes, notably the Bering Sea and western Alaska, and decreased over the northeast Pacific Ocean, and northerly winds gave way to southerly and westerly, at the beginning of the second week in December, that the long dry season came to an end.

The fire-weather season for 1929 in Oregon was somewhat below normal up to the forepart of September, with

both the fire losses and expenditures slightly less than usual. But September 3 ushered in the most hazardous fire weather experienced in years, continuing almost without interruption until September 16, a 2-week period. During this period, many of the existing fires jumped the fire lines and new ones that started were immediately whipped out of control, so that within a short time, protective organizations in several of the units were taxed beyond their capacity. This was not only the darkest period in the 1929 fire-weather season, but also in the history of organized forest fire protection.

The worst fire-weather situations west of the Cascades always come with the advent of the dreaded east wind, attended in summer time by high temperatures and low relative humidities. When the relative humidity drops to 35 per cent, and lower, west of the Cascades, and even to 50 per cent, and lower, near the coast, fire-weather conditions become critical, and protective organizations must keep constantly on the alert as long as the relative humidity remains low. Low relative humidities of 20 per cent, and lower, east of the Cascades create a bad fire-weather situation too, but it is probable that wind force is of equal importance with low relative humidity for these sections in the creation of bad fire-weather situations.

Relative humidities were very low from the summit of the Cascades all the way to the coast during those dark days of September. And winds, at time of gale force, were prevailing from the east. The prevailingly low relative humidities of this 2-week period came in three surges, respectively, on September 3 to 4, 6 to 11, and 15 to 16, coincident with decided increases of barometric pressure over the interior to the northeast and decreasing pressure near the middle Pacific coast. Fire-weather conditions were at their worst from the 6th to the 11th, when very low relative humidities prevailed, being extremely low, from 15 to 30 per cent, on the coast on the 6th, 7th, and 8th. What made burning conditions even worse for this period was that there was scarcely any of the normal recovery of relative humidity at night over the west slope of the Cascades, and the higher elevations of the coast range, the only recovery of importance at night being at the lower elevations of the coast range. Wind force at the higher elevations of the mountains is usually greater at night than in the daytime; wind records at several lookout points in the Cascades and the coast range also showed higher wind velocities at night for this 2-week period. Thus going fires burned as well at night as during the daytime at these higher elevations, sometimes better. The severity of the fire-weather conditions that persisted during this period for northwestern and central western Oregon is presented on the accompanying map of western Oregon, graphically showing the number of hours with relative humidity of 35 per cent, and lower, at all stations equipped with hygrothermographs:

This map shows that fire-weather conditions were most critical along the central-west slope of the Cascades at elevations ranging from 3,000 to 4,000 feet, thence northwestward to the northwestern portion of the State. At one logging camp in eastern Marion County, at an elevation of approximately 3,200 feet, the relative humidity was 35 per cent, and lower, for 283 hours during this 2-week period. Further, the relative humidity at this camp was 35 per cent, and lower, for 133 consecutive hours, and 30 per cent, and lower, for 88 consecutive hours; from 8 a. m. of the 6th to 3 a. m. of the 17th, an 11-day period, the relative humidity was 35 per cent, and lower, for 240 hours, while the highest relative humidity for this time was only 49 per cent. The relative humidity records at a lookout and at a fire warden's headquarters in adjoining sectors were analogous to those at the camp. Similar relative humidity conditions were also recorded at many of the other stations equipped with hydrothermographs on the west slope of the Cascades in both Oregon and Washington, although not so extreme as on the central-west slope of the Cascades in Oregon.

The area burned over in Oregon in 1929 totaled 312,255 acres. The total monetary loss was $2,311,627. Fire losses and expenditures had been below normal over the State up to September 6. Over 90 per cent of the fire losses occurred subsequent to September 6, and about 90 per cent of the money spent in fire suppression was on

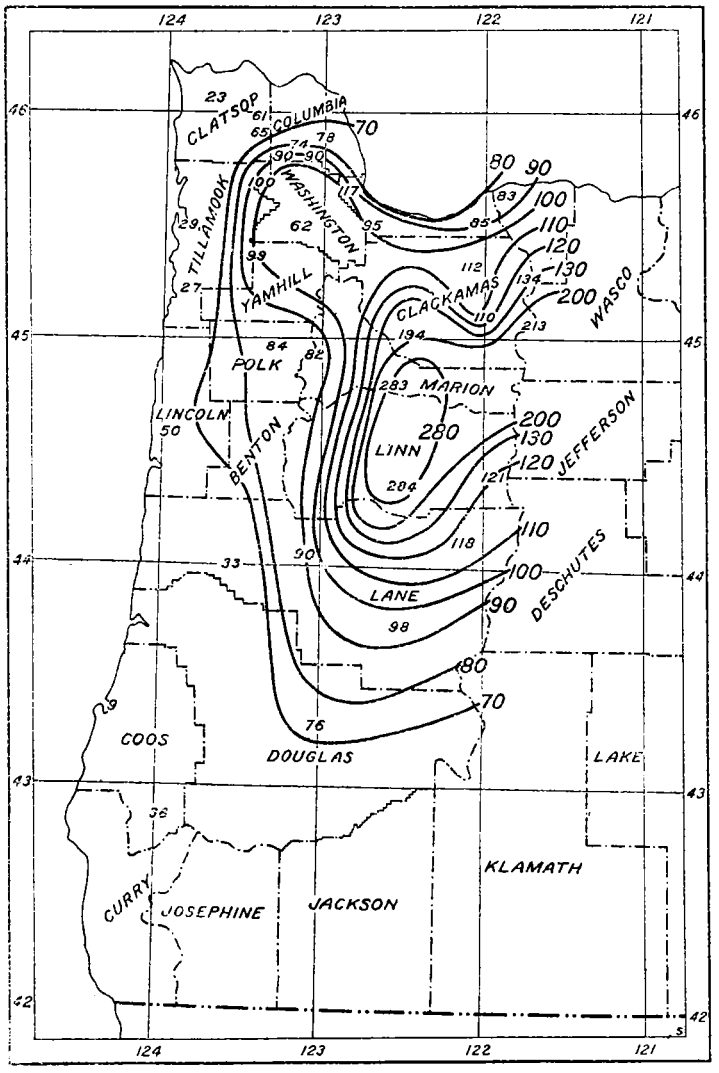

FIGURE 1.—Critical fire-weather in western Oregon as shown by the large number of hours with a minimum humidity of 35 per cent or less

fires subsequent to that time. At the end of August the Umpqua National Forest on the western slope of the southern Cascades had had only 13 fires, which had burned over a total area of only 1 acre, with fire-suppression costs of only $478; at the end of September 28 fires were reported for the season which had burned over 5,260 acres, and fire-suppression costs had mounted to approximately $50,000. The larger portion of the big increase for fires suppression and the big acreage burned over were incurred in the first two decades of September. The Douglas County Fire Patrol Association, adjoining the Umpqua National Forest on the west, reported that it had spent only about $500 for fire suppression to the end of August, but that over $20,000 had been spent by the

end of September. Fire-suppression costs and losses of a majority of all the other protective organizations west of the Cascades also took a decided upward trend in the first two decades of September, and on into the month of October for a few of these organizations. And it was necessary for some of the protective organizations to maintain patrol forces in the field until the first week in December, the first time in the history of organized protection.

The largest fire in Oregon occurred in eastern Marion County, and burned over approximately 46,000 acres with an estimated loss of $400,000, the greatest loss being in logs and logging equipment. There was also a big loss in reproduction. This fire started on September 6, and made its biggest run on the 6th, 7th, and 8th, but continued very troublesome until the 17th. Old experienced fire fighters on this fire stated burning conditions were the nearest thing to spontaneous combustion they had ever witnessed. Another large fire was one of about 20,000 acres in west Lane County, and another of about 18,000 acres in southern Clackamas County. There were also a number of other fires of from 2,000 to 5,000 acres. The site of the Yacolt Burn of 1902 in Washington was again largely swept by fire, the total acreage burned over amounting to approximately 150,000 acres. This fire was started early in August by a smoker, but made its biggest run in the first part of September.

Dense smoke prevailed west of the Cascades from the 6th to the 19th of September, being quite dense during the latter part of this period, and over eastern Oregon from September 12 to 19, being densest from the 16th to the 19th. Smoke was so dense in the Columbia River Gorge and vicinity from the 16th to the 18th that it was pitch dark most of the time and it was necessary to carry lanterns in the daytime in order to see to get around. Wind River Forest Experiment Station in Washington, in the Cascades north of the Columbia River Gorge, reported that the smoke cloud overhead on September 17, the bottom of which was about 500 feet above the ground, was so dense that it was actually pitch dark at the station in the middle of the day. The Weather Bureau cooperative observer at French Glen, in southeastern Oregon near the Idaho-Oregon boundary line, reported that the smoke was so dense on September 18 and 19 that visibility was not over 500 yards. The dense smoke made lookouts for sighting and reporting fires practically worthless, and observation by airplane very poor, and it became necessary for the protective organizations to put on extra guards for fire-patrol duty.

Special fire-weather warnings were telegraphed daily to the protective organizations of western Oregon from September 1 to 19, and again for several days at the end of the month. Many long-distance telephone calls were also received from those forestry interests desiring special information relative to fire-weather conditions.

There were recurrent periods of bad fire weather in October, November, and the first week in December, when burning conditions were good and gave the protective organizations and logging operators much concern.

Protective organizations in the Siskiyous and southern Coast Range sustained their heaviest fire losses of the season during the latter part of November and the first week in December. It was the first time in history that destructive fires have occurred so late in the season. The largest of these fires was the Barklow Mountain fire, which started the day before Thanksgiving and burned over more than 10,000 acres. Thanskgiving Day and night and the following day were bad fire-weather days, and were the days on which this fire and other fires made their biggest runs. Protection men reported that stiff east and northeast winds came in in a whirl, and that cold nights with dense fog prevailed in the lower valleys and levels while warm clear weather with relatively high temperatures and low relative humidities prevailed at the higher elevations. The barometric pressure was extraordinarily high at this time over the Plateau Region and western Canada.

The fire-weather season of 1929, within the history of Weather Bureau records, was undoubtedly the worst that has ever occurred in the Pacific Northwest, at least since 1868 when heavy fire losses occurred. According to the precipitation records at Astoria, Oreg., August and September of 1868 were very dry months, and it is well known that extremely heavy fire losses occurred in September, so extremely bad fire-weather conditions must have prevailed at that time. Fire-weather conditions for September of 1902 were bad and severe fire losses were sustained, but available weather records, while indicating serious fire-weather conditions for the most of one week, nevertheless, do not indicate that these conditions were as bad as for September for 1929. The extremely hazardous fire-weather conditions which prevailed during the latter part of the season for 1929 will long be remembered by the forest-fire protective organizations of Oregon and of all the Pacific Northwest as well.

FIRE WEATHER AND FIRE CLIMATE

By GEORGE W. ALEXANDER

[Weather Bureau Office, Seattle, Wash.]

Climatological data, for all portions of the earth's surface for which records of the weather elements are made, have become well standardized. Comparisons of the principal elements of the climate—temperatures, their means and extremes, and precipitation, its character, seasonal distribution and variability—are readily possible. Such comparisons are only possible, however, from the fact that there is uniformity of treatment of data, nationally and internationally, and the need for such uniformity is obvious. There is now a newly born, but rapidly developing, branch of meteorology and climatology for which no such uniformity of method of compilation of essential facts has been developed. Reference is made to the now rather widely spread studies of those phenomena known as "fire weather." While fire-weather data are being accumulated in increasingly large amounts, especially in parts of North America, there has as yet been no standardization of the ultimate treatment of such facts, so that a "fire climatology" may be established which will allow of comparison of the basic elements of the natural fire hazard over different regions as readily as a comparison of the general climate may be made at present. That there should be some such standardization would seem obvious enough. It is desired to set forth in the following paragraphs a tentative scheme, or suggestions, for a comprehensive fire climatology, which may form a basis for discussion, at least, and may ultimately, even if largely modified in accordance with the views of